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INTRODUCTION

This report is a continuation of the "Report of the Surveys of the Mountain Pine Beetle Infestation on the Beaverhead National Forest". Until 1933 we were chiefly concerned with the study of the development of the large outbreak of the mountain pine beetle in lodgepole pine on the Beaverhead Forest, but with the decided decrease of that infestation in 1933 and subsequently, except in 1934, other phases have assumed greater importance.

The light infestation remaining on the main Beaverhead Forest is now confined to its eastern part. Status of insect activity in 1938 in the Big Hole Basin was determined from the Battlefield check strip; for the rest of the main Beaverhead from the Wise River and Elkhorn check strips, from a few survey strips, and general observations. In the southeastern part of the Beaverhead, survey strips and general observations were also made on the Blacktain drainage in what is known as the Snow Crest Range and on the large forested area between the Ruby and Madison Rivers, known as the Gravelly Range.

PRESENT STATUS OF THE INFESTATION ON THE BEAVERHEAD NATIONAL FOREST

Except in 1934, when a slight increase occurred, the general trend of the infestation on the Beaverhead Forest since 1933 has been downward until 1938. The infestation is now confined to the Grasshopper, Melrose and Rattlesnake units of the main forest, and to the Snow Crest and Gravelly Ranges. There are possibly a few patches of infested whitebark pine at high elevations on the Lower and Upper Wise River units. In 1937 the outbreak reached the lowest ebb since surveys were begun in 1927. The total infestation increase or decrease over preceding years and percent of change are given for the period from 1927 to 1938 in table I.

TABLE I
CHANGES IN MOUNTAIN PINE BEETLE INFESTATION
BEAVERHEAD NATIONAL FOREST

Number of trees attacked by the mountain pine beetle					
1927	1928	1929	1930	1931	1932
67,691*	722,504	3,119,542	4,898,326	15,402,520	17,586,171
Increase	654,813	2,397,038	1,778,784	10,504,194	2,183,651
Decrease					
Percent change	957	332	57	214	14

1933	1934	1935	1936	1937	1938
869,647	1,284,510	255,632	147,725	31,170	59,150
	412,863				
16,716,524		1,026,878	107,907	116,555	27,980
-95	47	-80	-42	-79	90

*Estimate considered to have been too conservative; also 55,045 of these trees were treated in 1928. All data subsequent to 1927 corrected for effect of difference in date of survey on total infestation for each year.

The infestation in the Rattlesnake, Melrose and Grasshopper units has shown a decided increase since 1937, but is still light and many trees are lightly attacked. Of the lodgepole pine attacked by the mountain pine beetle only about 59 percent may be considered heavily attacked, 15 percent light, and 23 percent "green-sided" or pitched out. In lodgepole pine the per-acre infestation is about .211 tree, while whitebark pine supports .863 infested tree per acre. The preceding data apply to the Melrose and Rattlesnake units, with the adjoining Grasshopper unit revealing .084 tree per acre in lodgepole pine. No data were available for the whitebark pine on the latter area, but it is believed that species will show a much heavier infestation. On the Grasshopper unit only one-third of the trees attacked by the mountain pine beetle were overcome, which would seem to indicate that the infestation is not very aggressive.

The smaller bark beetles, including Pityogenes knechteli, Pityophthorus burkei, Ips radiatae and Ips oregoni are causing very little damage in healthy timber in the aforementioned three units, confining their activity chiefly to trees already weakened or damaged by other factors.

The areas on Birch and Rock Creeks which showed a concentration of bark beetle activity following more or less defoliation of the timber because of unseasonal cold temperatures continue to show losses. On Birch Creek the mountain pine beetle attacked an average of .54 tree

per acre in 1938 and secondaries 1.90 trees per acre. Only the more severely defoliated trees have been attacked by the beetles, those with less needle loss showing excellent recovery. Being an area of intensive use the dead timber has been rapidly removed from the area, thereby so opening up the stand as to leave the remaining living timber comparatively isolated and subject to windthrow and snow break. Further losses on this area from these two factors may be expected.

On the Rock Creek area Douglas fir seems to have suffered the greatest losses from both defoliation and bark beetles. The cutting of many Douglas fir incidental to road construction has undoubtedly absorbed much of the bark beetle brood which otherwise would have gone into weakened standing trees. There is a possibility that brood from these logs may cause the loss of many of the Douglas fir alongside the new road. On the area west of Brown's Lake, where defoliation has been serious, the average loss of Douglas fir in 1938 was .862 tree per acre. Lodgepole pine showed one-half that loss with .431 attacked tree per acre. It is probable that similar conditions exist on other areas on these units, but there was insufficient time to locate them and determine the losses. Outside of these limited areas, the infestation is comparatively light even though an increase has occurred this year.

The status of the mountain pine beetle is shown in table II.

TABLE II

COMPARISON OF INFESTATION FROM 1927-1938 CAUSED BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE
BEAVERHEAD NATIONAL FOREST - 1938

Unit	Acreage	1927-30	1931	1932	1933	1934	1935	1936	1937	1938
Pintlar	61,600	1,050,379	762,485	667,732	37,167	10,651	None	None	None	None
Mussigbrod	56,300	1,150,910	1,336,675	1,424,904	12,085	7,848	None	None	None	None
Battlefield	102,400	2,514,804	4,445,696	2,471,203	37,895	8,179	None	None	None	None
West Side	76,500	963,165	2,031,534	1,468,693	52,129	25,574	None	None	None	None
Jackson	75,800	976,351	1,404,498	1,730,767	51,279	16,191	None	None	None	None
Bloody Dick	108,160	569,470	1,551,339	2,796,036	55,603	34,744	Not over 15,000	Not over 15,000	None	None
Horse Prairie	57,000	248,653	167,124	93,525	32,092	33,425	Not over 9,000	Not over 9,000	None	None
Rattlesnake	68,400	29,431	117,990	513,334	63,915	220,487	63,270	63,270	10,602	19,000
Grasshopper	42,500	18,646	91,587	574,034	12,455	52,395	18,870	18,870	None	3,500
Warm Springs	54,500	245,376	1,135,856	1,736,678	42,241	63,310	Not over 11,500	11,500	None	None
East Side	86,200	824,789	1,519,783	660,867	13,403	13,298	None	None	None	None
Upper Wise R.	142,800	60,578	408,694	1,166,162	150,316	243,945	24,990	24,990	None	None
Lower Wise R.	59,000	106,746	231,068	893,323	133,578	134,856	10,325	10,325	None	None
Melrose	132,700	10,368	134,847	1,182,491	110,919	391,757	95,677	95,677	20,568	36,650
Lima	218,000	27,751	63,344	206,422	64,570	25,850	Not over 7,000	Not over 7,000	None	None
Total	1,341,860	8,795,417	15,402,326	17,586,171	869,647	1,282,510	255,632	255,632	31,170	59,150

Inspection of the preceding table reveals the lightness of the present infestation.

Activity of Secondary Bark Beetles

Activity of secondary bark beetles reached its lowest ebb in 1937, judging from the data secured from the Battlefield, Wise River and Elkhorn check strips. The increase noted in 1938 is believed to be due indirectly to unusually heavy winds which blew down many bark beetle-killed trees in 1937 and 1938. In their fall they damaged many of the remaining living trees. In addition wind and snow caused the windthrow, breakage and bending over of many of the smaller, living trees. Such trees made favorable host material for secondary bark beetles, in which they have considerably increased. The losses which have occurred on the Battlefield check strip in 1938 are shown in table III.

TABLE III

LOSSES FROM VARIOUS CAUSES ON BATTLEFIELD CHECK STRIP IN 1938 - LODGEPOLE PINE

D.b.h.	Primary cause of death*							Living trees injured by***				Windthrown green trees			
	Bark beetles	Peridermium**	Snow-break LP	Snow-break DF	Falling trees LP	Falling trees DF	No apparent cause	Snow or wind LP	Snow or wind DF	Falling trees LP	Falling trees DF	DF	LP	AF	
1	2	2	9					30	3		3				49
2		8	10		3		2	35	7	7	2	1			75
3	3	6	3	1	2			11	2	1	1				30
4			1	3	1			4				1			10
5	1				2	1		1		1		1			7
6				1	1					6					8
7										1			1		2
8								1						1 (9")	2
11			1									1 1 (12") 1 (15")			4
	6	16	24	5	9	1	2	82	12	16	6	6	1	1	187
No. per acre	.167	.444	.667	.140	.250	.028	.056	2.280	.333	.444	.166	.166	.028	.028	5.197
Percent of tot. loss	3.2	8.6	12.8	2.7	4.8	.5	1.1	43.9	6.4	8.5	3.2	3.2	.5	.5	
Total trees containing secondaries							1.752								3.445

*Filled in by secondary bark beetles

**Including Pityogenes knechteli, Pityophthorus burkei, Ips radiatae, and Ips oregoni.

***Mechanical injury only--probably will "fill in" and be killed by secondaries later.

Inspection of the table will reveal that only slightly over one-third of the total trees killed or damaged on the strip in 1938 harbored bark beetles. Of the latter only slightly over 3 percent seem to have been the result of primary attack by these smaller beetles. Many living trees were bent over, broken off, or uprooted by the action of wind and snow. While an unusually severe wind undoubtedly is responsible for much of the damage it must be remembered that the killing of so many trees by bark beetles opened up the stand sufficiently to make the remaining trees much more susceptible to windthrow and snowbreak. The 1938 loss on the strip from wind and snow breakage amounted to 70 percent of the total, of which 57 percent was in lodgepole pine. This wind and snow break loss does not include the trees damaged by the fall of insect-killed trees. Lodgepole pine so damaged amounted to 13.3 percent of the total and Douglas fir 3.7 percent.

Windfall with its accompanying damage to the remaining living timber is becoming quite a factor on the Battlefield strip. No windthrows were noted until 1936, when 6 trees were found, followed by 32 in 1937 and 81 in 1938. The years when killed and windthrown are shown in the following tabulation.

TABLE IV

WINDTHROW OF MOUNTAIN PINE BEETLE KILLED LODGEPOLE PINE ON BATTLEFIELD CHECK STRIP TO 1938

Wind-thrown:	Year killed						Percent of total stand losses
	Pre 1931	1931	1932	1933	1934	Totals	
1936	5	--	1	--	--	6	5.0
1937	12	11	5	3	1	32	26.9
1938	41	14	18	7	1	81	68.1
Totals	58	25	24	10	2	119	
Percent	48.8	21.0	20.2	8.4	1.7		
Percent dead trees for each year are of total killed by insects	26.5	46.9	26.1	.4	.1		100

Analysis of the preceding table will show that the greatest amount of windthrow is occurring in the trees killed early in the outbreak, an expected trend, as their roots would naturally have rotted the most and be least windfirm.

The average diameter of the windthrown trees has been greater than that of the trees killed in spite of many small uprooted trees. It is probable the trees of greatest diameter were also of the greatest height and consequently more liable to windthrow. An increase in windthrow may be expected with each succeeding year. Not only will rotting of the roots of the dead trees make them decreasingly windfirm, but the fall of neighboring trees will open up the stand still further and make the remaining trees more susceptible to windthrow.

On the Wise River check strip activity of secondary bark beetles also increased, chiefly as a result of damage to living trees by wind,

snow or other agencies. Only four of the 15 trees had not been so damaged prior to attack. All of the injured trees had been "filled in" by secondary insects in contrast to conditions on the Battlefield strip where many trees were still unattacked. Enough secondary beetles were present on the Wise River strip to attack the increased number of weakened trees, but on the Battlefield strip the weakened trees were apparently too many for the supply of insects. It is believed that due to a greater supply of damaged material from snowbreak, windbreak, and other factors, the activities of secondary bark beetles will continue at a higher level than in a forest that has not been devastated by a mountain pine beetle outbreak.

Just as on the Battlefield strip, it is the trees killed during the early part of the outbreak that make up the bulk of those windthrown up to the present time. Of the total windthrown, 73 percent were killed prior to 1931, 18 percent in 1931, and 4.5 percent in each of 1932 and 1934. The lighter and more recent losses with consequent less opening up of the stand and the larger proportion of timber not susceptible to mountain pine beetle attack will probably result in dead trees standing for a longer average period on this than on the Battlefield strip.

On the Elkhorn check strip slight activity of the mountain pine beetle is still noted, with one killed and two "pitched-out" trees, or an average of .08 tree per acre. Secondary bark beetles assumed an apparent primary role in attacking 36 trees, or an average

of 1.0 per acre. These trees showed no evidence of weakening or damage from other factors. In addition secondary insects "filled in" or attacked 18 other weakened or damaged trees. The average of all trees attacked by secondary bark beetles per acre was 1.5.

A summarization of secondary bark beetle activity on the portions of the Beaverhead Forest represented by the three check strips indicates that for the area adjoining the Big Hole Basin an average of 2.03 trees per acre were attacked, while on that part represented by the Wise River and Elkhorn strips .91 tree per acre was attacked. For the main portion of the forest, losses from secondaries would amount to about 1,700,000 trees for the 840,000 acres of which the Battlefield strip is considered representative and about 450,000 trees for the remaining approximate 500,000 acres of the main forest of which the other two strips are thought to be representative. The activity of these insects compared with that of the mountain pine beetle since 1933 is shown in table V.

TABLE V
LOSSES DUE TO SECONDARY BARK BEETLES ON THE BEAVERHEAD FOREST 1933-1938

	1933	1934	1935	1936	1937	1938
Number of trees attacked by secondary bark beetles:	988,588	7,383,098	4,395,093	1,637,000	208,000	2,150,000
Percent the losses caused by secondaries are of total losses for year	53	85	94.5	91.7	87	97.3

Inspection of the preceding table reveals how great has been the increase in the number of trees killed by these secondary insects in the period from 1937 to 1938. In addition an average of 2.8 trees per acre were bent over or otherwise damaged in the Big Hole Basin area, or an additional 2,350,000 trees.

Infestation on Other Parts of the Beaverhead Forest

Limited time prevented the running of sufficient strips to determine the acreage of each timber type on the Gravelly and Snow Crest Range areas. However, from the writer's knowledge of the region, an estimate of these acreages has been attempted, and the per-acre infestation secured from the strips has been applied to them to secure the total infestation. The results are shown in table VI, which follows.

TABLE VI
BARK BEETLE INFESTATION ON THE SOUTHEASTERN PART OF THE BEAVERHEAD FOREST IN 1938

Attacking Insect	Blacktail Hills				Gravelly Range			
	Timber		Infested trees		Timber		Infested trees	
	Species	Acreage	Per acre	Total	Species	Acreage	Per Acre	Total
Mountain pine beetle	LP	12,000	.5	6,000	LP	70,000	1.05	73,500
Mountain pine beetle	WBP	3,000	2.1	6,300	WBP	15,000	1.3	20,500
Douglas fir beetle	DF	6,500	--	--	DF	60,000	.4	24,000
Englemann spruce beetle	ES	500	.05	25	ES	5,000	None	None
				12,325				118,000

From the preceding table it may be seen that considerable infestation is present on these two areas. It is thought severe defoliation from frost damage a few years ago may have sufficiently weakened the trees to have given bark beetles a chance to increase in numbers. Douglas fir seems to have been the chief sufferer but lodgepole and whitebark pine also were seriously weakened over limited areas.

The increase of the mountain pine beetle on this part of the forest may be merely temporary but conditions are more favorable for an increase here than on the main portion of the Beaverhead because there is still a great deal of host material. On the main part of the forest only the units east and south of Wise River contain sufficient favorable host material to support an outbreak.

Douglas fir has suffered light but increasing losses from the Douglas fir beetle for a number of years, but severe losses have been confined chiefly to areas where frost has caused more or less defoliation and weakening of the trees.

The Engelmann spruce beetle does not seem to be causing much loss on the Beaverhead Forest, which is in contrast to the increasing and heavy losses on part of the Gallatin Forest a few miles to the southeast.

THE INFESTATION ON THE TARGHEE FOREST

Data for only a small portion of the Targhee Forest are available near Ashton, Idaho. On that area conditions from a check strip indicate the following changes since 1934.

COMPARISON OF BARK BEETLE ATTACKS ON ASHTON CHECK STRIP OF 36 ACRES FROM 1934 to 1938

Year	1934	1935	1936	1937	1938
Total trees attacked	399	479	263	47	11
Percent killed by D.m.	--	50.1	20.8	4.3	None
Percent killed by Ips sp. and other secondary bark beetles	--	1	29.6	93.7	100
Percent green-sided and pitched out from D.m. and second bark beetle attack	--	48.9	49.4	2	None

Mountain pine beetle activity seems to have almost ceased on the Antelope Flat area of the Targhee Forest. One tree which had two "pitched-out" attacks comprised the total of attacked trees on the strip. Outside of the strip three lightly mountain-pine-beetle-attacked trees were observed. On the strip secondary insects had invaded 11 trees, 9 of them subsequent to examination of the strip in 1937 or early in the spring of 1938, and 2 in 1938. All had previously been weakened by mountain pine beetle or secondary bark beetle attack except one which had been seriously weakened by the pitch moth. Windfall of the beetle-killed trees has commenced with four being windthrown in 1938. The number might have been higher had not woodcutters removed many of the largest and tallest dead trees from part of the strip.

The Douglas fir beetle is still active on the Targhee Forest but data are lacking as to the amount of it.

CONCLUSIONS

The injury and breakage of many living trees, chiefly of the smaller diameters, by wind, snow and falling insect-killed trees is undoubtedly responsible for the major portion of the increase in the numbers of secondary bark beetles over the Beaverhead Forest as a whole. On limited areas concentrations of secondary bark beetle activity are due to severe defoliation of trees following unseasonable temperature. This weakening of the trees is also believed to be responsible for the concentration and increase in the mountain pine beetle and Douglas fir beetle activity over limited areas.

Activity of the mountain pine beetle on the Blacktail Creek drainage and the Gravelly Range seems to be of a more aggressive character than that on the main portion of the Beaverhead. This statement is based on the larger proportion of successfully attacked lodgepole pine in these outlying portions of the Beaverhead Forest. In whitebark pine the difference in intensity of attack is slight between the main and outlying portions of the Beaverhead.

No apparent reason seems evident to explain the increase in the mountain pine beetle infestation on the outlying portions of the Beaverhead and the decided decrease on nearby areas of the Targhee Forest.

The outbreak of the Douglas fir beetle is persisting on both the Beaverhead and Targhee Forests but is apparently not increasing or causing serious losses except on areas where unseasonable weather has resulted in serious defoliation of the trees.

SUMMARY

Mountain pine beetle activity has apparently ceased in the Big Hole Basin area of the Beaverhead National Forest, has increased in the western parts of the main Beaverhead, and is increasing, aggressive and causing noticeable loss on the Blacktail Creek drainage and the Gravelly Range.

Much favorable host material, as the result of snow, wind and injury from falling trees to the remaining living stand on the Beaverhead Forest, has caused a decided increase in the activity of secondary bark beetles. In the Big Hole Basin, where losses from the mountain pine beetle have been very heavy, the previously mentioned factors have caused the greatest accumulation of host material and activity of secondary bark beetles with lesser amounts on the adjoining units and very little on the Gravelly Range and the Blacktail drainage.

On the Targhee Forest secondary bark beetles are still active in weakened trees, but mountain pine beetle attacks are very few.

Douglas fir beetle activity is comparatively light but persisting on the Beaverhead and Targhee National Forests.

Windthrow of bark-beetle-killed lodgepole pine is increasing on the Beaverhead and will constitute an increasing telephone-line, trail, and road-maintenance cost and fire hazard. Windthrow or damage to living trees may be expected to increase with the opening of the stand from windthrow of the trees killed by the mountain pine beetle.